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OIL-REPELLENT AGENT COATING DEVICE
[Hatsuzai tofu sochi]

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(54) [Title of the Invention] Oil-Repellent Agent Coating Device /1*

[Claim(s)] /2

[Claim 1] An oil-repellent agent coating device comprising coating heads used for coating an oil-repellent agent on the heteromorphic inner diameter portion of a bearing-constituting member having a heteromorphic inner diameter portion whose inner diameter varies nonlinearly in the axial direction and an oil-repellent agent supplying device which supplies a fixed amount of the oil-repellent agent to the aforesaid coating heads; said oil-repellent agent coating device characterized by the aforesaid coating heads being composed of: i) a main body member that is provided with a discharge opening in the radial direction and is provided with a) a columnar protruding portion which fits with the heteromorphic inner diameter portion of the aforesaid bearing-constituting member at a prescribed gap and b) a seating portion on which the lower end face of the aforesaid bearing-constituting member is seated in a fluid-tight manner and ii) a holding member which holds the aforesaid bearing-constituting member from outside; and a guide passage used for guiding the oil-repellent agent from the aforesaid oil-repellent agent-supplying device to the aforesaid jetting outlet being formed on the aforesaid main body member.

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*Number in the margin indicates pagination in the foreign text.

[Claim 2] The oil-repellent agent coating device of Claim 1, characterized by the aforesaid columnar protruding portion being a cylindrical portion and the aforesaid seating portion being an O-ring.

[Claim 3] The oil-repellent agent coating device of Claim 1, characterized by a discharge means being provided on the aforesaid holding member.

[Detailed Specifications]

[0001][Technical Field of the Invention]

The present invention relates to an oil-repellent agent coating device which automatically coats an oil-repellent agent on a bearing-constituting member, which is a bearing-constituting component of a fluid dynamic pressure bearing where the site to be coated with the oil-repellent agent has a complex shape.

[0002][Prior Art]

In a fluid dynamic pressure bearing which is generally equipped with a shaft, sleeve, and lubricating oil packed in the micro-gaps formed between these and the bearing-constituting member, and is composed by being sealed by a capillary sealing portion, an oil-repellent agent is coated on a prescribed site of the bearing-constituting member so as to hold the lubricating oil between the micro-gaps wherein a dynamic pressure-generating grooves, i.e., a dynamic pressure-generating portion is provided and so that the lubricating oil does not leak out from the capillary sealing portion.

[0003] For example, in the publication of Tokukai JP-A S58-50321 there is disclosed a fluid dynamic pressure bearing having two surfaces which move symmetrically, a group of parallel grooves formed on one or both sides of these surfaces and tapered in the symmetrically-moving direction thereof, and a lubricating oil which fills the space between these surfaces, forming the gaps between two members respectively having the aforesaid two surfaces so that the vicinity in which the aforesaid group of grooves is formed is the narrowest, allows the aforesaid lubricating oil to be penetrated and held only in the vicinity where this group of grooves was formed by means of the force of the capillary phenomenon between the aforesaid two members and on which the oil-repellent agent is coated expansively on at least one of the aforesaid two surfaces.

[0004] Incidentally, since this oil-repellent agent is coated by manual work, there is a problem because it is difficult to coat the oil-repellent agent with good positional precision at a prescribed site on the inclined face of the bearing-constituting member forming the capillary portion. This coating work becomes more difficult the more miniaturized the fluid dynamic pressure bearing of the motor becomes and the more complex the external shape becomes. Therefore, to solve this problem, the following two solutions have been provided.

[0005] The first conventional solution for solving the difficulty of coating the oil-repellent agent with good positional precision on a prescribed site of the bearing-constituting member

forming a capillary seal has been adopted as the fluid dynamic pressure bearing disclosed in the publication of Tokukai JP-A H10-73126. A corner portion having an oil-repelling function is provided around the entire periphery at a site outside the air-liquid interface, whereby no oil-repellent agent is employed. Although it is certainly an essential solution, the size and structure of the bearing for obtaining the oil-repelling function rivaling that of an oil-repellent agent must be specified, so it cannot be adopted for fluid dynamic pressure bearings of various types and sizes.

[0006] The second conventional solution for solving the difficulty of coating with good positional precision at a prescribed site of the bearing-constituting member forming a capillary seal is employed as a fluid dynamic pressure bearing using the shaft and sleeve disclosed in the publication of Tokukai JP-A H8-140304 as the bearing-constituting member. First the oil-repellent agent is coated on the entire bearing-constituting component, the oil-repellent agent is subsequently removed from the parts where the oil-repellent agent is not to be coated, i.e., the part forming the dynamic pressure-generating portion and the part forming the capillary seal portion. More specifically, the entire shaft member is impregnated with the oil-repellent agent, this oil-repellent agent is coated over the entire surface thereof, the dynamic pressure-generating groove is subsequently formed at a prescribed site on the outer peripheral surface of the shaft member by a plastic deformation work and cutting

work using a press, and moreover, a tapered groove is formed in the capillary seal portion as well by a cutting work, and as a result, the oil-repellent agent is removed from the dynamic pressure-generating portion and the site forming the capillary seal portion. Similarly, the entire sleeve member is impregnated with the oil-repellent agent, the entire surface thereof is coated with the oil-repellent agent, and the dynamic pressure-generating portion is subsequently formed at a prescribed site on the inner peripheral surface of the sleeve member to remove the oil-repellent agent.

[0007] According to the above-mentioned second conventional solution, the time and labor for coating the oil-repellent agent can be curtailed drastically. However, this second conventional solution presents a problem where the oil-repellent agent is used wastefully because the oil-repellent agent is coated in parts of the bearing-constituting member where it is not needed, that is to say, in wide parts having an overwhelmingly large surface area. In addition, since a cutting oil is employed when the dynamic pressure-generating groove and the tapered groove of the capillary seal portion are formed by means of cutting, there is also an inconvenience because the oil-repellent agent thus coated becomes contaminated with the cutting oil, or the oil-repellent agent coated in the bearing-constituting member-degreasing step after the cutting work is removed from the site where it is required.

[0008][Problems to be Solved by the Invention]

The problem to be solved by the invention is to provide an oil-repellent agent coating device which automatically and evenly coats an oil-repellent agent on a bearing-constituting component which is /3 the bearing-constituting component of the fluid dynamic pressure bearing and having a heteromorphic inner diameter portion whose inner diameter varies nonlinearly in the axial direction.

[0009][Means for Solving the Problems]

The oil-repellent agent coating device of Claim 1 which solves the above-mentioned problems is comprises coating heads used for coating an oil-repellent agent on the heteromorphic inner diameter portion of a bearing-constituting member having a heteromorphic inner diameter portion whose inner diameter varies nonlinearly in the axial direction and an oil-repellent agent supplying device which supplies a fixed amount of the oil-repellent agent to the aforesaid coating heads. And, the aforesaid coating heads are composed of: i) a main body member that is provided with a discharge opening in the radial direction and is provided with a) a columnar protruding portion which fits with the heteromorphic inner diameter portion of the aforesaid bearing-constituting member at prescribed gap and b) a seating portion on which the lower end face of the aforesaid bearing-constituting member is seated in a fluid-tight manner and ii) a holding member which holds the aforesaid bearing-constituting member from outside, and at the same time, a guide passage used for guiding

the oil-repellent agent from the aforesaid oil-repellent agent-supplying device to the aforesaid jetting outlet is formed on the aforesaid main body member.

[0010] The oil-repellent agent coating device of Claim 2 which solves the above-mentioned problems is the oil-repellent agent coating device of Claim 1 which has the aforesaid columnar protruding portion composed of a cylindrical protrusion and the aforesaid seating portion is composed of an O-ring.

[0011] The oil-repellent agent coating device of Claim 3 which solves the above-mentioned problems is the oil-repellent agent coating device of Claim 1 which is composed of the aforesaid holding member being provided with a discharge means.

[0012][Embodiments of the Invention]

The oil-repellent agent coating device in an embodiment of the present invention is composed of coating heads 10a, 10b, 10c, 10d and 10e, as shown by the block diagram in Figure 1, and an oil-repellent agent-supplying device 20 which supplied a fixed amount of the oil-repellent agent to these coating heads 10a to 10e.

[0013] The oil-repellent agent-supplying device 20 is composed of supply pipes 21a, 21b, 21c, 21d and 21e, where one end is connected respectively to the coating heads 10a to 10e, a pump 22 where the other ends of the supply pipes 21a to 21e are connected to the discharge opening thereof, an oil-repellent agent storage tank 24 connected to the inlet of this pump via the pipe 23, solenoid valves

25a, 25b, 25c, 25d and 25e respectively provided midway therealong the supply pipes 21a to 21e, and a controller 26 which controls the opening and closing of these solenoid valves 25a to 25e and the operation of the pump 22.

[0014] The bearing-constituting component on which the oil-repellent agent is coated by means of the oil-repellent agent coating device pertaining to the present invention is, e.g., a ring-shaped bearing-constituting component 5 having a heteromorphic inner diameter portion 5a whose inner diameter varies nonlinearly in the axial direction, as shown in Figure 2; it is a component wherein the oil-repellent agent is coated on its heteromorphic inner diameter portion 5a. Moreover, 5b, 5c and 5d comprise an outer peripheral surface, upper end face and lower end face of the ring-shaped bearing-constituting component 5.

[0015] As shown in Figure 3, the coating heads 10a to 10e are all composed of a main body member 11 having a columnar protruding portion 12 and a seat portion 13 and a ring-shaped holding member 16 which holds the ring-shaped bearing-constituting component 5 from outside. The columnar protruding portion 12 is a cylindrical protrusion. And so that it fits with the heteromorphic inner diameter portion 5a of the ring-shaped bearing-constituting component 5 at a prescribed gap, the inner diameter and length thereof are determined. A jetting outlet 14 is formed at the columnar protruding portion 12 in the lower portion midway therealong in the axial direction. It is

favorable that a plurality of this jetting outlet 14 be arranged at equal intervals in the radial direction. When the ring-shaped bearing-constituting component 5 is arranged on the coating heads, the seat portion 13 on which the lower end face 5b is seated in a fluid-tight manner is an O-ring. This O-ring 13 is accommodated in an annular groove formed on the circumference at the lower end portion of the columnar protruding portion 12. A guide passage 15 which guides the oil-repellent agent from the oil-repellent agent-supplying device 20 to the jetting outlet 14 is formed on the main body member 11. In addition, a discharge pathway 17 is formed on the ring-shaped holding member 16.

[0016] Next, work for coating the oil-repellent agent on the ring-shaped bearing-constituting component 5 using the oil-repellent agent coating device shown in Figure 1 is described next. First of all, in preparatory work, a worker arranges the ring-shaped bearing-constituting component 5 on the coating heads 10a to 10e. The cross section in Figure 4 and the perspective view in Figure 5 are states in which this preparatory work is completed. That is, the heteromorphic inner diameter portion 5a of the annular lid member 5 and on which the oil-repellent agent has been coated fits with the columnar protruding portion 12, so that the lower end face 5b thereof is seated on the seat portion 13 in a fluid-tight manner, then the coating heads 10a to 10e are arranged on the main body member 11,

while the outer peripheral surface thereof is held by the ring-shaped holding member 16.

[0017] The oil-repellent agent stored in the tank 24 is pumped, via the respective supply pipes 21a to 21e, to the coating heads 10a to 10e disposed with the ring-shaped bearing-constituting component 5 by way of the preparatory work. The oil-repellent agent thus pumped is jetted through the jetting outlet 14 via the guide passage 15 formed through the main body member 11. This jetted oil-repellent agent completely fills the gap formed between the heteromorphic inner diameter portion 5a and the outer peripheral surface of the columnar protruding portion 12, to the extent that it substantially overflows the upper opening of this gap. When this state is attained, the supply of the oil-repellent agent is interrupted, and the ring-shaped bearing-constituting component 5 is dismantled from the coating heads 10a to 10e by a worker. Although the bearing-constituting component thus dismantled has a surplus of oil-repellent agent remaining in the heteromorphic inner diameter portion 5a thereof, the oil-repellent agent can be shaken off, whereby it is automatically coated evenly on the heteromorphic inner diameter portion 5a of the ring-shaped bearing-constituting component 5.

[0018] The supply of a fixed amount of the oil-repellent agent to the coating heads 10a to 10e is controlled by the controller 26. That is to say, the controller 26 controls the operation of the pump 22 for pumping the oil-repellent agent to the supply pipes 21a to 21e

from the oil-repellent agent storage tank 24, and at the same time, it controls the opening and closing of the solenoid valves 25a to 25e disposed respectively along 21a to 21e, to control the supply and interruption of the oil-repellent agent to the coating heads 10a to 10e. Moreover, if this coating work was repeated a number of times, the oil-repellent agent pooled in the space 18 between the top of the main body member 11 of the coating heads 10a to 10e and the inner peripheral surface of the holding member 16; hence, it was discharged by the discharge pathway 17.

[0019] Furthermore, the fluid dynamic pressure bearing provided with the bearing-constituting component on which the oil-repellent agent was coated using the oil-repellent agent coating device /4 pertaining to the present invention will be described. This fluid dynamic pressure bearing has been disclosed in Tokugan No. H11-082280 by the applicant of this application. It is composed of a flanged shaft 1 comprising a ring member 3 and a cylinder member 2, a sleeve 4 which receives this flanged shaft 1, and an annular lid member 5 (for a thrust-pressed member). The sleeve 4 has a lower small-diameter cylinder portion having a bottom and an upper large-diameter cylinder portion having an open end which opens to the air, respectively. An annular stepped portion is formed at the open end of the sleeve 4, while the annular lid member 5 is press-fit into this annular stepped portion so that the open end of the sleeve 4 becomes occluded. A radial dynamic pressure-generating groove is, e.g., a

herringbone groove, which is formed around the outer peripheral surface on the lower side of the cylinder member 2. In addition, a thrust dynamic pressure-generating groove is, e.g., a spiral herringbone groove. These grooves are formed respectively on the top and inferior surface of the ring member 3.

[0020] Micro-gaps R1, R2, R3, R4 and R5 formed from approximately several μm to several tens of μm between the flanged shaft 1, sleeve 4 and annular lid member 5 are filled with a lubricating oil F. This lubricating oil F is sealed by a lower capillary seal S1 and an upper S2. The first capillary seal S1 forms an annular micro-gap, approximately several tens of μm to several hundreds of μm, between the lower small-diameter inner peripheral side of the annular lid member 5 and the outer peripheral surface of the cylinder member 2 of the flanged shaft 1, with the inner lower peripheral side of the annular lid member 5 being tapered. The second capillary seal S2 forms an annular micro-gap, approximately tens of μm to several hundreds of μm, between the upper large-diameter inner peripheral surface of the annular lid member 5 and the outer peripheral surface 6b of the annular protruding portion of a hub 6 press-fit to the cylinder member 2 of the flanged shaft 1, with the large-diameter upper inner peripheral side of the annular lid member

5 being tapered. The annular lid member 5 is a bearing-constituting component having the heteromorphic inner diameter portion whose inner diameter varies nonlinearly in the axial direction, and the oil-repellent agent is coated on this heteromorphic inner diameter portion.

[0021] A buffering annular void W is formed between the first capillary seal S1 and the second capillary seal S2. Consequently, the sealed structure of this fluid dynamic pressure bearing has a triple structure having the lower first capillary seal S1, the upper second capillary seal S2 and the middle buffering annular void W. In short, the lower first capillary seal S1 becomes the annular tapered groove opening which fans out toward the buffering annular void W, and the lubricating oil filled in the fluid dynamic pressure bearing is prevented from leaking into the buffering annular void W by the capillary phenomenon and the surface tension thereof.

[0022] When the lubricating oil filled in the fluid overflows the lower first capillary seal S1 by a sudden thermal expansion or large impact, the buffering annular void W accommodates the lubricating oil thus overflowing to prevent it from leaking to the outside. If a larger amount of lubricating oil overflows which cannot be accommodated by the buffering annular void W, the first upper capillary seal S1 keeps the lubricating oil from leaking to outside the fluid dynamic pressure bearing according to the capillary phenomenon and the surface tension. The annular lid member 5 which is

the bearing-constituting component having the heteromorphic inner diameter portion whose inner diameter varies nonlinearly in the axial direction is adopted for realizing such a triple sealed structure for preventing leakage of the lubricating oil.

[0023] Although the oil-repellent agent coating device pertaining to the present invention was described in detail above by citing an embodiment provided with five coating heads, the number of coating heads naturally can be increased or decreased, as needed. In addition, the fixed quantity oil-repellent agent supplying device 20 is not limited to the one disclosed in Figure 1 either; it may be one having another configuration. Furthermore, the bearing-constituting component on which the oil-repellent agent was coated by means of the oil-repellent agent coating device pertaining to the present invention may be any kind of component as long as it is a bearing-constituting component having a heteromorphic inner diameter portion whose inner diameter varies nonlinearly in the axial direction; it is not limited to the component as shown in Figure 2 or 6.

[0024][Advantages of the Invention]

By employing the oil-repellent agent coating device pertaining to the present invention, the efficiency of the oil-repellent agent coating work on the bearing-constituting component having the heteromorphic inner diameter portion whose inner diameter varies nonlinearly in the axial direction and the quality of the coating thereof are improved. That is to say, the oil-repellent agent was

coated rapidly and evenly on a large bearing-constituting component. As a consequence, by employing the bearing-constituting component on which the oil-repellent agent was coated according to the present invention, a reduction in the manufacturing costs of a fluid dynamic pressure bearing and an improvement in quality could be planned.

[Brief Description of the Drawings]

[Figure 1] A block diagram showing the configuration of the oil-repellent agent coating device in an embodiment of the present invention.

[Figure 2] A cross section of the bearing-constituting component having a heteromorphic inner diameter portion whose inner diameter varies nonlinearly in the axial direction.

[Figure 3] A cross section in an embodiment of a coating head.

[Figure 4] A cross section in an embodiment of a coating head disposed with the bearing-constituting component having a heteromorphic inner diameter portion.

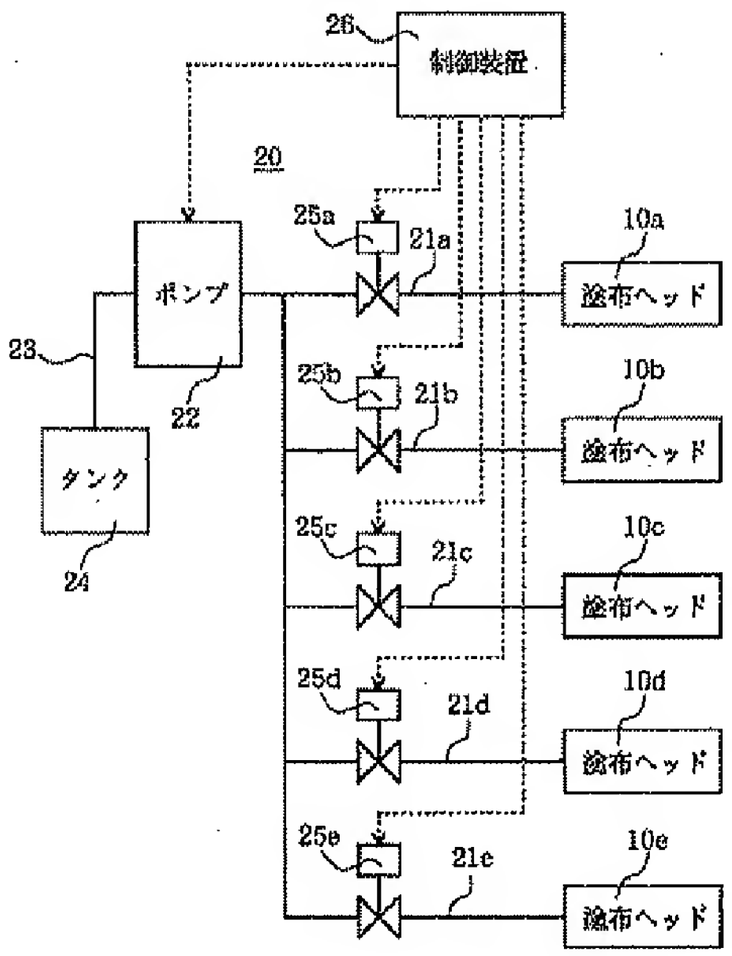
[Figure 5] A perspective view in an embodiment of a coating head disposed with the bearing-constituting component having the heteromorphic inner diameter portion.

[Figure 6] A cross section in an embodiment of the fluid dynamic pressure bearing provided with the bearing-constituting component having a heteromorphic inner diameter portion. In short, the micro-gap is shown exaggerated.

[Explanation of the Codes]

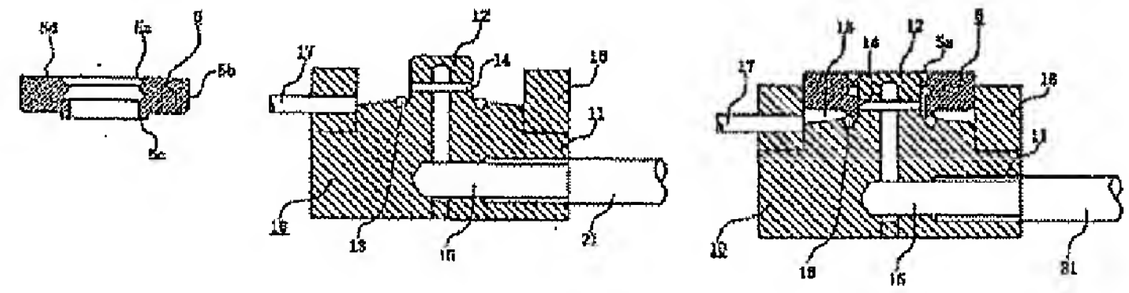
1: flanged shaft; 2: cylinder member; 3: ring member; 4: sleeve; 5: bearing-constituting component or annular lid member; 5a: heteromorphic inner diameter portion; 5b, 5c and 5d: outer peripheral surface, upper end face and lower end face of the annular lid member 5; 6: cup-shaped hub; R1, R2, R3, R4 and R5: micro-gaps; F: lubricating oil; 10, 10a to 10e: coating heads; 11: main body member; /5 12: columnar protruding portion or cylindrical protrusion; 13: seat portion or O-ring; 14: jetting outlet; 15: guide passage; 16: ring-shaped holding member; 17: discharge pathway; 18: void; 20: oil-repellent agent-supplying device; 21, 21a to 21e: supply pipes; 22: pump; 23: hub; 24: tank; 25a to 25e: solenoid valves; 26: controller

[Figure 1]



Key: (26) controller; (22) pump; (24) tank; (10a) coating head; (10b) coating head; (10c) coating head; (10d) coating head; (10e) coating head

[Figure 2] [Figure 3] [Figure 4]



[Figure 5] [Figure 6]